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# TICKS OF MEDICAL IMPORTANCE OCCURRING IN THE WESTERN HEMISPHERE

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Final Report for Period June 1986 - June 1987



USAF SCHOOL OF AEROSPACE MEDICINE
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## NOTICES

This final report was submitted by personnel of the Epidemiology Services Branch, Epidemiology Division, USAF School of Aerospace Medicine, Human Systems Division, AFSC, Brooks Air Force Base, Texas, under job order SUPT-XXEK.

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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

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This publication, serving as a handbook for medical and pest control personnel, describes each tick species of medical importance occurring in the Western Hemisphere. Guidance for the identification of these species as well as discussions about the diseases they harbor and transmit are included. In addition, appropriate tick control measures and suggestions for proper tick removal from humans are presented.

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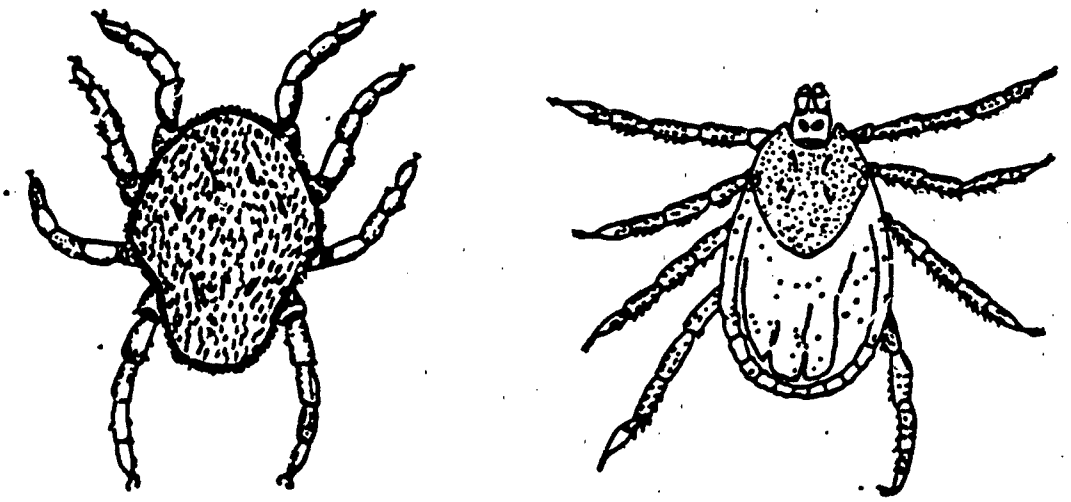
## INTRODUCTION

Ticks are large mites that feed obligately on the blood of mammals, reptiles, and birds. They have a leathery, undifferentiated body with no distinct head, but the mouthparts do form a headlike structure. Ticks are aggressive blood suckers occurring throughout much of the world. They occur in several life stages with mature ticks and nymphs having 4 pair of legs; the larvae have 3 pair.

The two families of ticks recognized in North America (Fig. 1 A,B) are Ixodidae (hard ticks) and Argasidae (soft ticks). Hard ticks are the most commonly encountered and are scutate (scutum present) with sexual dimorphism (male and females look obviously different) and the blood-fed females are capable of enormous expansion. Their mouthparts are anteriorly attached and visible from dorsal view. On the other hand, soft ticks are nonscutate without obvious sexual dimorphism and are mainly adapted for feeding rapidly and leaving the host promptly. Their mouthparts are generally subterminally attached and not visible from dorsal view. Due to this tick group's secretive habits, most people have never seen a soft tick.

Ticks are of significant medical and veterinary importance, and knowledge of species present in a given area is important to physicians, veterinarians, the military, and livestock personnel. In fact, ticks are the most important vectors of disease pathogens to domestic animals throughout the world and are second only to mosquitoes as transmitters of disease agents to man. Ticks may harbor and transmit to people various disease agents such as protozoa, viruses, bacteria, rickettsiae and toxins. Ticks may also cause irritation and discomfort directly as a result of their bites.

Several factors are unique to ticks enabling them to survive adverse conditions and transmit disease: they are highly sclerotized (a protective, chitinous covering); can attach firmly while feeding and do not dislodge easily; can withstand long periods of starvation; have a wide host range (which ensures more certain sources of blood); are able to deposit large



SOFT TICK

A

HARD TICK

B

Figure 1. Comparison of adult soft tick and hard tick.

numbers of eggs; feed slowly, permitting wide dispersion while attached to a host; and are relatively free from natural enemies. Another critically important factor in disease transmission by ticks is their ability to transovarially transmit some disease agents from generation to generation; thus, ticks themselves may serve as reservoirs for a particular pathogen.

While some hard ticks complete their development on only 1 or 2 hosts, most commonly encountered ticks have a 3-host life cycle. A fully fed female tick drops from a host animal to the ground and lays from 5,000 to 18,000 eggs. The eggs hatch in about 35 days into a 6-legged seed-tick stage, which feeds predominantly on small animals. The fully fed seed ticks drop to the ground and transform into 8-legged nymphs. These nymphs seek an animal host and likewise feed and drop to the ground; they then transform into adult ticks, thus completing the life cycle (Fig. 2A).

The biology of soft ticks differs from that of hard ticks in several ways. Adult soft ticks feed repeatedly whereas hard tick females feed once, lay eggs, and then die. Argasid females may feed and lay eggs several times but lay fewer eggs than do hard ticks. Soft tick species may also undergo several nymphal molts before reaching the adult stage. Figure 2B shows representatives of each motile life stage of soft ticks.

Considerable information is available concerning ticks and tickborne diseases in the United States of America (USA); however, information on Mexican, Central, and South American ticks, as well as that of the Caribbean Islands, is limited and often contradictory. For example, there are numerous records from South America of Ixodes ricinus, the European castor bean tick and a known vector of several tickborne diseases. However, closer examination revealed that this South American tick was a new species (1). The purpose of this study was to compile, in a readily available reference, a guide to the ticks of medical importance occurring in the Western Hemisphere and have it sufficiently self-explanatory and illustrated for use by nonspecialists.

These records come from citations in the literature and the Rocky Mountain Laboratory records. In addition, to clarify Central and South American distributions of some species, consultations with researchers in those geographic areas were made.

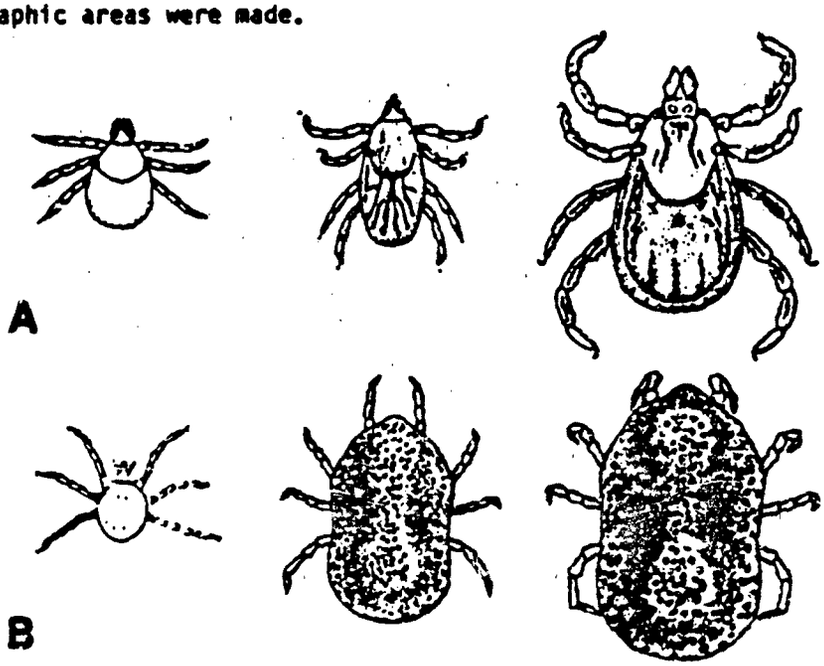



Figure 2. All motile life stages of hard ticks and soft ticks.

## LIST OF SPECIES OF MEDICAL IMPORTANCE OCCURRING IN THE WESTERN HEMISPHERE

| Species | Why Important |
|---|---|
| **Family Argasidae** | |
| *Ornithodoros coriaceous* | Extremely painful bite |
| *Ornithodoros hermsi* | Relapsing fever |
| *Ornithodoros parkeri* | Possibly relapsing fever |
| *Ornithodoros rudis* | Relapsing fever |
| *Ornithodoros talaje* | Relapsing fever |
| *Ornithodoros turicata* | Relapsing fever |
| **Family Ixodidae** | |
| *Amblyomma americanum* | Tularemia, possibly RMSF and Lyme disease |
| *Amblyomma cajennense* | RMSF in Central and South America |
| *Dermacentor andersoni* | RMSF, Colorado tick fever, tick paralysis |
| *Dermacentor variabilis* | RMSF, tularemia, tick paralysis |
| *Dermacentor occidentalis* | Colorado tick fever, tick paralysis |
| *Ixodes dammini* | Lyme disease, babesiosis |
| *Ixodes pacificus* | Lyme disease |
| *Ixodes scapularis* | Possibly Lyme disease and RMSF |
| *Rhipicephalus sanguineus* | Possibly RMSF in Mexico, Central and South America, canine ehrlichiosis |

## TICK-ASSOCIATED DISEASES OCCURRING IN THE WESTERN HEMISPHERE

### Lyme Disease

Lyme disease is a newly recognized (late 1970's) human illness found in widely separated regions of the United States, Europe, and Australia. In Europe, this illness is more often referred to as erythema chronicum migrans (ECM) disease. Most cases reported in the USA are from the New England area;

however, cases have been reported from many other states also, particularly Wisconsin, Minnesota, and California. Lyme disease is characterized by a migrating annular "red ring" lesion (ECM) which may be followed after several weeks or months by various types of arthritic, neurologic, or cardiac abnormalities. The disease is rarely fatal but can be long and debilitating.

Lyme disease is rapidly becoming the most prevalent tickborne disease in the USA with approximately 1,500-2,000 cases being reported every year. The disease is caused by a spirochete transmitted to man primarily by the deer tick, Ixodes dammini, a member of the Ixodes ricinus complex. Other tick species may also be vectors of the disease, as well as other blood-feeding insects. Research studies have confirmed the spirochetal etiology of the disease and the agent has been named Borrelia burgdorferi in honor of the man primarily responsible for identifying the causative agent of the disease, Dr Willy Burgdorfer.

## Rocky Mountain Spotted Fever

Rocky Mountain spotted fever (RMSF) is one of the most severe of all infectious diseases, and it is characterized by headache, chills, fever, and a rash which characteristically begins on the extremities including the soles and palms. In severe cases there may be convulsions, coma, and death. Approximately 700-1,000 cases of RMSF are reported in the USA annually; however, the disease also occurs in Canada, Mexico, and Central and South America (although occasionally under different names).

The causative agent of RMSF is a rickettsia, Rickettsia ricketsii, which is transmitted to man by several species of ixodid ticks. Two of the most important vectors are Dermacentor andersoni and D. variabilis. When infected ticks feed, rickettsiae are transmitted to the host via salivary secretions. In nature, the disease agent occurs in cycles among small mammals with ticks being the transmitters; man is infected as an accidental or dead-end host only. Ticks themselves also may serve as reservoirs of the disease because R. rickettsii is transovarially transmitted from generation to generation in ticks. However, not all ticks are infected with RMSF, and within a vector species (e.g., D. variabilis) only about 1-5% are usually infected.

## Tularemia

Tularemia is characterized by influenza-like symptoms with an initial bout of severe fever, temporary remission, and then another period of fever for about 2 weeks. Also, there is often a local lesion at the bite site (if vectorborne), conjunctivitis, and enlarged lymph nodes. Tularemia is widespread over much of the USA, Canada, and parts of Mexico. Approximately 200-300 cases are reported in the USA annually.

The causative agent of tularemia is the bacterium, Francisella tularensis, which is transmitted to man by various avenues (food, water, etc.), as well as several species of ixodid ticks and possibly other blood-sucking insects. The disease may also be contracted by skinning infected rabbits or rodents. The seasonal incidence of tularemia in the USA reflects these two modes of transmission; there are increases in reported cases during fall and winter in the East and Midwest due to the shooting and skinning of rabbits, and in summer in the Southwest and West as a result of tick bites.

## Relapsing Fever

Relapsing fever in man is characterized by acute onset of fever about 1 week after the bite of an infected tick. Since soft ticks generally feed for only a short period (and, therefore, are not rigidly attached for several days like hard ticks), the victim may be unaware of any recent tick bites. Fever may last 4-5 days followed by a similar afebrile period, and so on through several fever episodes. Relapsing fever is essentially worldwide in distribution and occurs in the western USA, Canada, as well as Central and South America. Approximately 10-20 cases of relapsing fever are diagnosed in the USA each year.

The causative agent of relapsing fever is a spirochete, Borrelia recurrentis, or various tick-adapted strains of this organism (many authors maintain that each tick-adapted strain is a distinct species). Although relapsing fever is transmitted by lice, ticks of the genus Ornithodoros are also involved in the transmission of the disease. Rodents serve as natural sources of infection for ticks, and transmission is by the bite of ticks of either sex in all active stages. Fluids of the tick's coxal glands released

while feeding may also be important in disease transmission because spirochetes present in the fluid may be introduced into the bite wound or penetrate unbroken skin.

## Colorado Tick Fever

Colorado tick fever is an acute febrile, dengue-like disease sometimes accompanied with a rash. Often there is a brief remission period followed by a second bout of fever. Occasionally encephalitis and severe bleeding develop in children. The disease occurs in all the Rocky Mountain states of the USA as well as British Columbia, Canada. About 200-400 cases of Colorado tick fever are reported in the USA annually, although many cases go unreported.

The causative agent of Colorado tick fever is an arbovirus in the genus Orbivirus of the family Reoviridae and is the only commonly occurring tick-transmitted viral disease in the USA. Dermacentor andersoni ticks are the primary vectors of the disease to man although D. occidentalis have also been found naturally infected in Oregon and California. The disease circulates in nature among small rodents. Transstadial passage (tick stage to tick stage) of the virus occurs in D. andersoni and unfed nymphs overwinter the virus.

## Babesiosis

Human babesiosis is a malaria-like disease of varying severity which becomes clinically apparent 1 to 4 weeks after exposure. The disease is characterized by fatigue, anorexia, fever, chills, headache, and generalized myalgia. Human babesiosis occurs in the Western Hemisphere primarily in the Massachusetts and New York area of the USA, but particularly Nantucket Island. Over 100 cases of human babesiosis have been eported in the USA since 1969.

The infecting organism of American human babesiosis is the rodent piroplasm, (protozoan) Babesia microti, found primarily in the white-footed mouse. The vector to humans is exclusively Ixodes dammini that appears to

be abundant only where numerous deer are found. The present limited focus of American babesiosis may be related to deer abundance and increasing contact of humans outdoors with vegetation harboring rodents and ticks.

## Tick Paralysis

Ticks may cause a paralysis in people that is reversible when the ticks are removed. The characteristic symptom is an ascending flaccid paralysis which may terminate fatally if ignored. The disease occurs in various regions of the world and affects man and animals and sometimes even birds. In the Western Hemisphere, the greatest number of tick paralysis cases have occurred in North America and are mainly due to the tick, D. andersoni, with the highest incidence near the border of British Columbia, Canada and the northwestern USA. Central and South America are largely free of tick paralysis although there have been isolated reports from Venezuela and Uruguay. Disease incidence is not very high, but there have been approximately 300-400 documented human cases in British Columbia, Canada since 1900. Most experts believe that tick paralysis is caused by a toxin in the salivary glands transmitted to people when the ticks feed. The rapid recovery of patients after removal of a causal tick suggests toxins may be excreted rapidly or metabolized by the body.

## Canine Ehrlichiosis in Humans

Canine ehrlichiosis is a rickettsial disease of dogs that occurs throughout many regions of the world and is widespread in the southern half of the USA. The causative agent of the disease is Ehrlichia canis, believed to be transmitted by all stages of the brown dog tick, Rhipicephalus sanguineus. Recently, human cases of the malady have been increasingly recognized. In 1986, the first confirmed human case of canine ehrlichiosis was contracted in Arkansas, with at least six additional cases subsequently confirmed in Texas. Also, in Oklahoma, health department personnel reviewed numerous 1986 sera samples of suspected spotted fever cases (but were negative for RMSF) and found 16 sera significantly positive for E. canis. Six patients from Georgia and South Carolina were also recently identified with serological evidence of recent infection with E. canis. These reports indicate that

possibly many suspect cases of RMSF may actually be ehrlichiosis. Symptomology in humans includes many spotted fever type of manifestations such as fever, anorexia, myalgia, arthralgia, headache, nausea, and a rash. If this pathogen is indeed becoming adapted to the human host, it is likely that incidence of human (canine) ehrlichiosis will increase in many parts of the world. Although R. sanguineus is the vector of E. canis to dogs, it may not be the sole vector to humans. Whereas R. sanguineus does occasionally bite people in many parts of the world, in the USA it only infrequently bites people. For this reason, other ticks may be involved in the USA-acquired human cases of ehrlichiosis.

## SPECIES ANNOTATIONS

### Ornithodoros coriaceous Koch

Pajaroella Tick

**Medical Importance:** Although not positively linked to disease transmission, this species produces a "venomous bite" that is reported to be very painful (2). There are many tales about the seriousness of the bite, and the tick is said to be feared like a rattlesnake by certain native Mexicans.

**Distribution:** This species (Figs. 3, 4) occurs along the Pacific Coast of California into Mexico (3). Hoffmann(4, 5) has reported the species from the Mexican states of Oaxaca and Chiapas.

**Hosts:** Man, deer (5), and swallow (3).

**Seasonality:** Varies with geographic location, hosts, and habitat. In warmer areas, it may be active throughout the year.

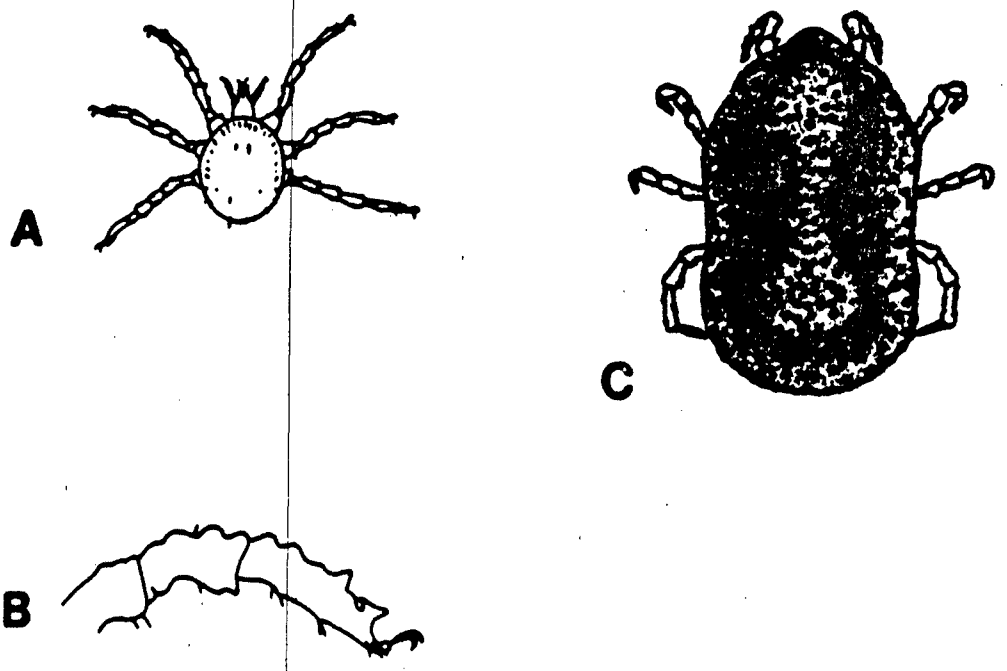



Figure 3. Larva (A), leg I of adult (B), and adult (C) of Ornithodoros coriaceous.

**Diagnostic Characters***: Margin of body thick, rounded without definite sutural line; integument mammillated or tuberculated; eyes present on lateral margins near Coxae I and II; cheeks (flaps at the sides of the mouthparts) absent; dorsal humps on Tarsi I present.

**Remarks:** Ornithodoros coriaceous is a large soft tick species often found in the soil in deer and cattle bedding areas. Larvae may attach and remain on the host for about 7 days. There may be 3 to 5 nymphal stages and the time required to reach adult stage is about 4 months.

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*Adult specimens only, see section "Definition of Terms Used for Diagnostic Characters" for illustrations and definitions used herein.

Figure 4. Geographic distribution of Ornithodoros coriaceous.

## Ornithodoros hermsi Wheeler, Herms, and Meyer

No Common Name

**Medical Importance:** Ornithodoros hermsi is a proven vector of relapsing fever spirochetes in the Rocky Mountain and Pacific Coast states, USA.

**Distribution:** This species (Figs. 5, 6) occurs in the USA in the states of California, Nevada, Idaho, Oregon, Utah, and Colorado (3, 6) as well as British Columbia, Canada (7).

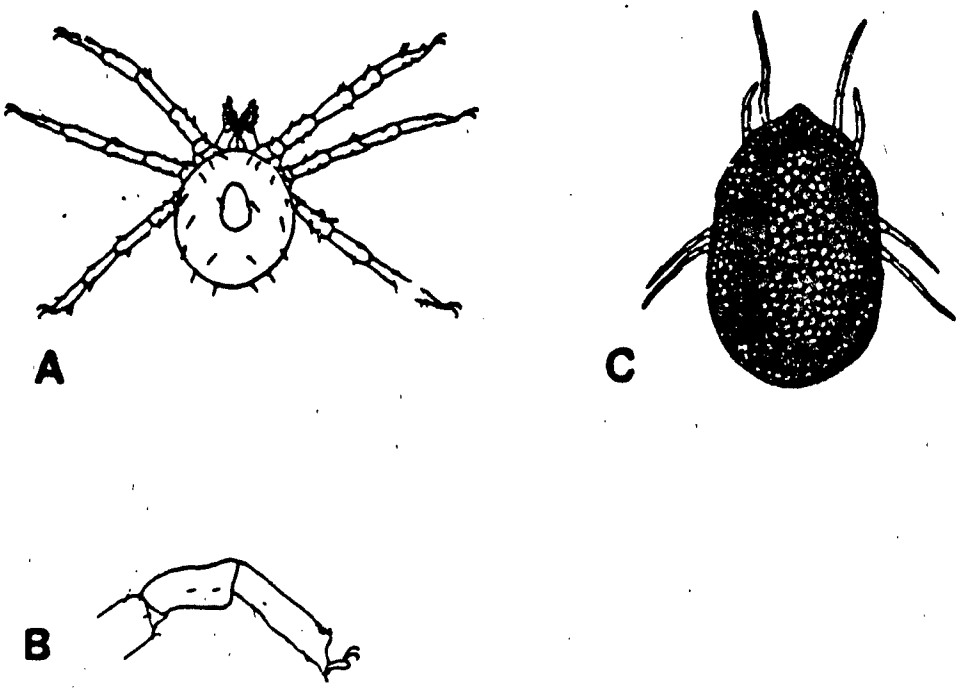



Figure 5. Larva (A), leg I of adult (B), and adult (C) of Ornithodoros hermsi.

Figure 6. Geographic distribution of Ornithodoros hermsi.

**Hosts:** Rodents (8) and man (8, 9).

**Seasonality:** Varies with geographic location, hosts, and habitat.

**Diagnostic Characters:** Margin of body thick, rounded without definite sutural line; integument mammillated or tuberculated; cheeks (flaps at the sides of the mouthparts) absent; dorso-ventral grooves present; dorsal humps on Tarsi I absent.

**Remarks:** Ornithodoros hermsi is often found infesting corners and crevices of vacation or summer cabins. Larvae only remain attached to a host for about 15-20 min. There are usually 4 nymphal molts, and the cycle from egg to egg is about 4 1/2 months.

## Ornithodoros rudis (=venezuelensis) Karsch

No Common Name

**Medical Importance:** This species is the most important vector of relapsing fever spirochetes in Panama, Colombia, Venezuela, and Ecuador (8).

**Distribution:** This species (Figs. 7, 8) occurs in Panama (10), Paraguay, Colombia (3), Venezuela (11), and Ecuador (8).

**Hosts:** Domestic birds and man (10, 11).

**Seasonality:** Varies with geographic location, hosts, and habitat. This species may be active in warmer areas throughout the year.

**Diagnostic Characters:** Margin of body thick, rounded without definite sutural line; integument mammillated or tuberculated; cheeks (flaps at the side of the mouthparts) present; dorsal humps on legs absent, discs small and inconspicuous.

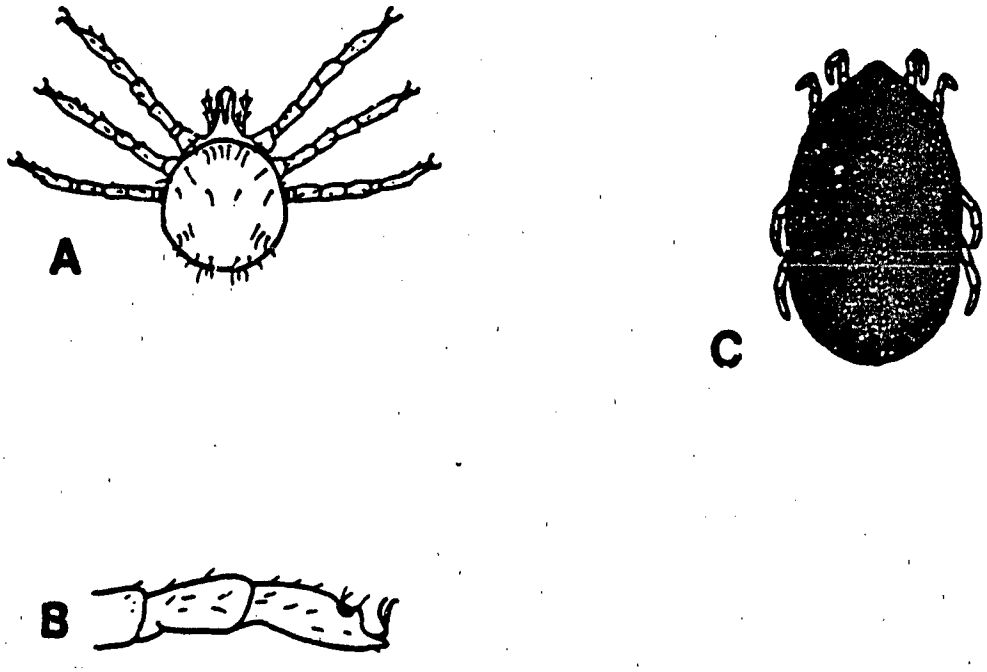



Figure 7. Larva (A), leg I of adult (B), and adult (C) of Ornithodoros rudis.

**Remarks:** Ornithodoros rudis appears to be especially adapted as a parasite of humans, but feeds on other animals as well. This tick species is a night feeder with the larval stages engorging rapidly. There are 3 to 4 nymphal stages, and the time required from larvae to adult is about 3 months.

## Ornithodoros parkeri Cooley

No Common Name

**Medical Importance:** Although Ornithodoros parkeri has been found naturally infected with relapsing fever spirochetes, it has not thus far been associated with human cases (12).

Figure 8. Geographic distribution of Ornithodoros rudis.

**Distribution:** This species (Figs. 9, 10) occurs in the USA in the states of California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming (3). It has also been reported from Baja California, Mexico (13).

**Hosts:** Rodents, rabbits, burrowing owls (3) and infrequently man (14).

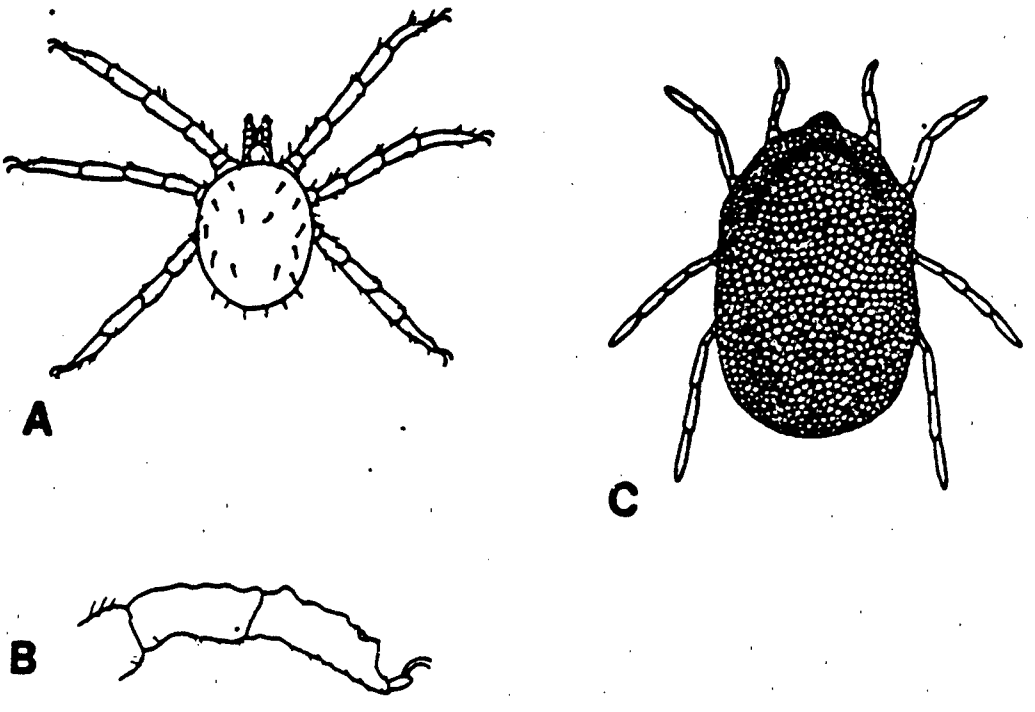



Figure 9. Larva (A), leg I of adult (B), and adult (C) of Ornithodoros parkeri.

**Seasonality:** Varies with geographic location, hosts, and habitat.

Figure 10. Geographic distribution of Ornithodoros parkeri.

**Diagnostic Characters:** Margin of body thick, rounded without definite sutural line; integument mammillated or tuberculated; cheeks (flaps at the sides of the mouthparts) absent; dorso-ventral grooves present, dorsal humps present on Tarsi I; subapical dorsal protuberance absent from leg IV, dorsal humps absent from Tarsus IV; mammillae small, many, and crowded together.

**Remarks:** Ornithodoros parkeri is commonly present in nests of the burrowing owl and less prone to bite people than are some other species of Ornithodoros. The larvae feed rapidly and thus do not remain attached to a host very long. There are 3 to 5 nymphal instars with developmental time from larva to adult being about 6 months.

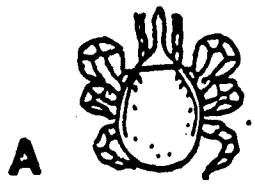
## Ornithodoros talaje (Guerin-Meneville)

No Common Name

**Medical Importance:** This species transmits the agent of relapsing fever to man in Guatemala, Panama, and Colombia (8).

**Distribution:** This species (Figs. 11, 12) occurs in the USA in the states of Florida, Texas, Arizona, Nevada, Kansas, New Mexico, and California (8, 15). However, Hoogstraal (13) maintains that it has only been reported from Kansas and California, USA. It has been reported from Mexico in the states of Baja California, Chiapas, Guerrero, Morelos, Oaxaca, Puebla, Sinaloa, Sonora, Veracruz, and Yucatan (5). This species has also been reported from Venezuela (11), Uruguay (16), Brazil (17), French Guiana (18), Panama (10, 19), Ecuador (20), and Chile (21). Hoffmann(5) notes that this species has also been reported from Guatemala, Colombia, Argentina, and the Galapagos Islands.

**Hosts:** Rodents (principally) and man (19) as well as birds, bats, pigs, cattle, horses, opposums, and snakes (5, 10).



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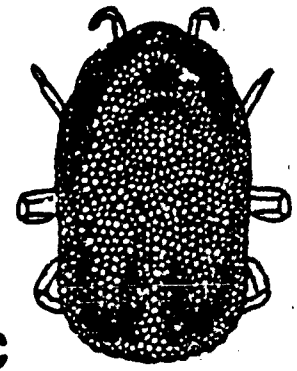

C

B

Figure 11. Larva (A), leg I of adult (B), and adult (C) of Ornithodoros talaje.

**Seasonality:** Varies with geographic location, hosts, and habitat. This species may be active in warmer geographic areas throughout the year.

**Diagnostic Characters:** Margin of body thick, rounded without definite sutural line; integument mammillated or tuberculated; large cheeks (flaps at the sides of the mouthparts) present; discs large and noticeable, legs with surfaces micromammillated.

**Remarks:** According to Dunn (19), Ornithodoros talaje adults are seldom observed in dwellings and are not avid parasites of man. The larvae remain attached to a host for several days. There are 3 to 4 nymphal stages and developmental time from larvae to adult is about 8 months.

Figure 12. Geographic distribution of Ornithodoros talaje.

## Ornithodoros turicata (Duges)

### Relapsing Fever Tick

**Medical Importance:** Ornithodoros turicata may produce an intense irritation and edema at the bite site in humans (3). This species also serves as a vector of relapsing fever spirochetes in portions of Kansas, Oklahoma, Texas, and other southwestern states (3).

**Distribution:** This species (Figs. 13, 14) occurs in the USA in the states of Texas, New Mexico, Oklahoma, Kansas, California, Colorado, Arizona, Florida, and Utah (3). It has been reported from Mexico in the states of Aguascalientes, Coahuila, Gunanjuato, Morelos, Queretaro, San Luis Potosi, and Sinaloa (5). This species has also been found in Venezuela (11), Honduras (22), Bolivia (23), Chile (21), and Argentina (16). However, recent publications such as Hoogstraal (13) report that the records of this species from Central and South America are probably incorrect.

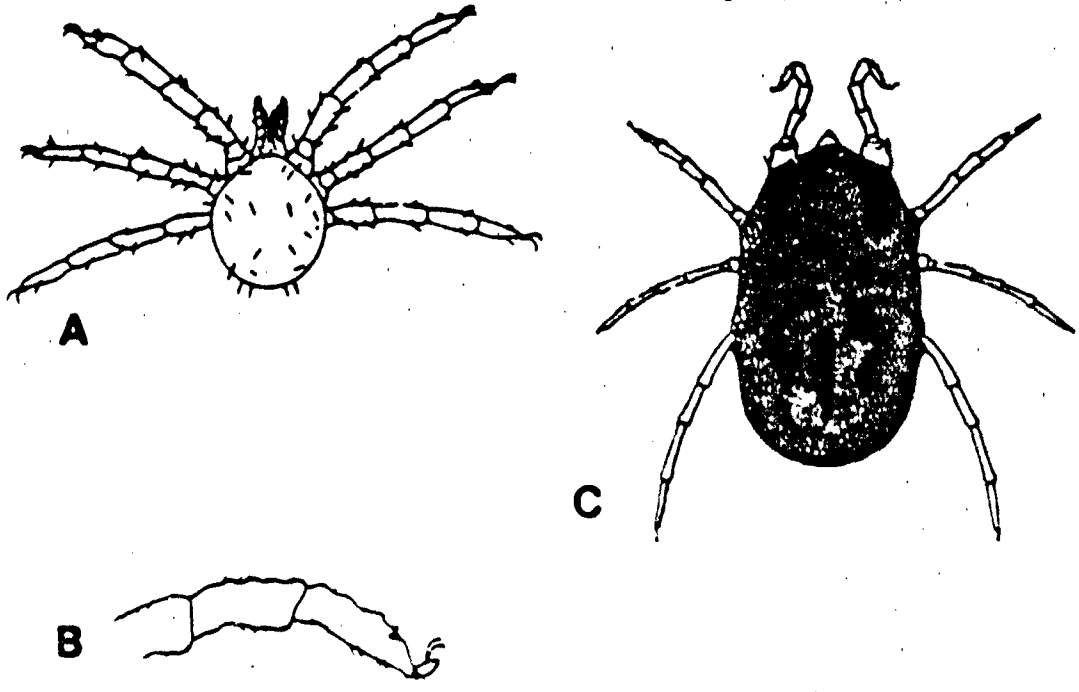


Figure 13. Larva (A), leg I of adult (B), and adult (C) of Ornithodoros turicata.

Figure 14. Geographic distribution of Ornithodoros turicata.

**Hosts:** Specimens have been collected from rattlesnakes, turtles, birds, rodents, rabbits, sheep, cattle, horses, pigs, and man (3, 5).

**Seasonality:** Varies with geographic location, hosts, and habitat. This species may be active in warmer geographic areas throughout the year.

**Diagnostic Characters:** Margin of body thick, rounded without definite sutural line; integument mammillated or tuberculated; cheeks (flaps at the sides of the mouthparts) absent; dorso-ventral grooves present, dorsal humps present on Tarsi I; subapical dorsal protuberance absent from leg IV, dorsal humps absent from Tarsus IV; mammillae large, relatively few in number, not crowded together.

**Remarks:** Ornithodoros turicata is often found in burrows used by rodents or burrowing owls. Cooley and Kohls (3) report the bite to be painless but followed in a few hours by intense local irritation and swelling. Subsequently, subcutaneous nodules may form which persist for months. There are 3 to 5 nymphal stages and the time required for development from larva to adult is approximately 6 months.

## Amblyomma americanum (Linnaeus)

Lone Star Tick

**Medical Importance:** This species transmits the pathogen of tularemia to man (24) and is reported to transmit the agents of Lyme disease (25) and RMSF (26). However, recent studies have indicated that Amblyomma americanum may not be an important vector of RMSF (27, 28).

**Distribution:** This species (Figs. 15, 16) occurs in the USA in central Texas east to the Atlantic Coast and north to approximately Iowa and New Jersey (8). It has been reported from Mexico in the northern states of Coahuila, Nuevo Leon, and Tamaulipas (5). It has also been occasionally reported from Panama (19), Venezuela (11), Argentina, Guatemala, Guayana, and Brazil (5, 29). However, Central and South American records of this species may not be valid.

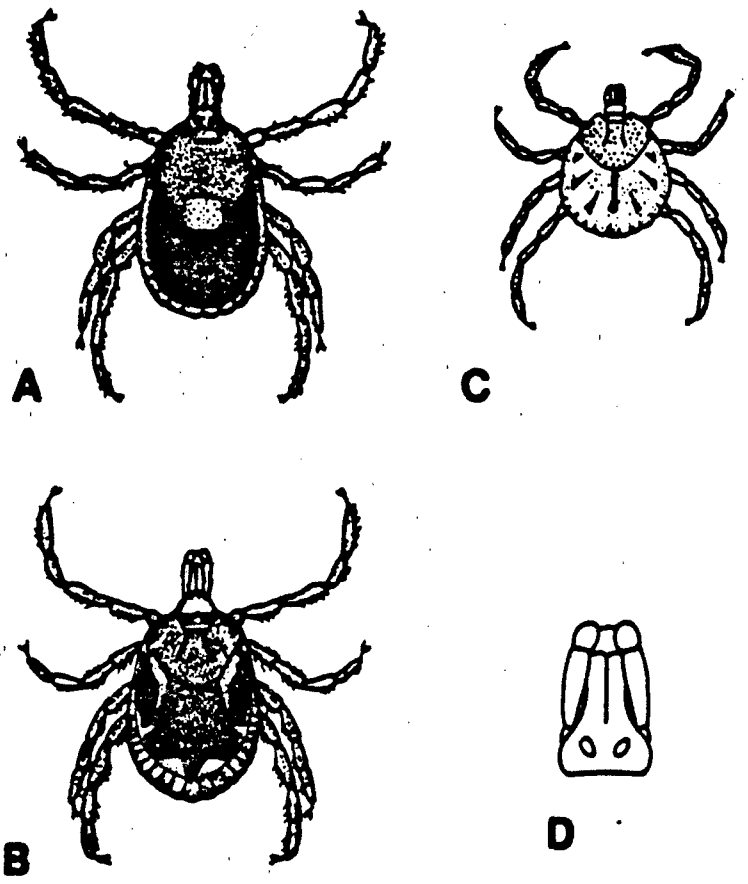


Figure 15. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Amblyomma americanum.

**Hosts:** Amblyomma americanum is extremely aggressive and nonspecific in its feeding habits. All three motile life stages of this species will feed on a wide variety of mammals and ground feeding birds (8, 30).

**Seasonality:** Amblyomma americanum adults and nymphs are generally active from early spring through midsummer (31) with larvae being active from late summer into early fall.

Figure 16. Geographic distribution of Amblyomma americanum. Occasional records from Central and South America not included.

**Diagnostic Characters:** Festoons present; eyes present; scutum ornate; basis capitulum not laterally produced; coxa I not bifid; second segment of palpi twice as long as wide; males with internal spur of coxa I moderately long and scutum with inverted horseshoe markings at posterior edge; females with external spur of coxa I distinctly longer than internal and scutum with distinct, single white spot.

**Remarks:** Amblyomma americanum is probably the most annoying and commonly encountered tick occurring in the southern USA. In some rural areas almost every person has been bitten by these ticks at one time or another. Lone star ticks are most often found in interfacing zones between forested and open (meadow) areas, especially where there is an abundance of deer or other hosts. They seldom occur in high numbers in the middle of pastures or meadows because of low humidities and high daytime temperatures present in those areas. Larvae may survive from 2 to 9 months; nymphs and adults 4 to 15 months each. Females usually deposit 3,000-8,000 eggs.

The female lone star tick is often falsely referred to as the "spotted fever tick" because of the single white spot visible on its back. However, this spot has nothing to do with the presence or absence of RMSF. Both A. americanum and A. cajennense adults have very long mouthparts and can produce painful bites.

## Amblyomma cajennense (Fabricius)

Cayenne Tick

**Medical Importance:** Amblyomma cajennense is probably the most commonly encountered and aggressive of all Central and South American ticks. This species is considered a vector of RMSF rickettsiae in Mexico, Panama, Colombia, and Brazil (32, 33).

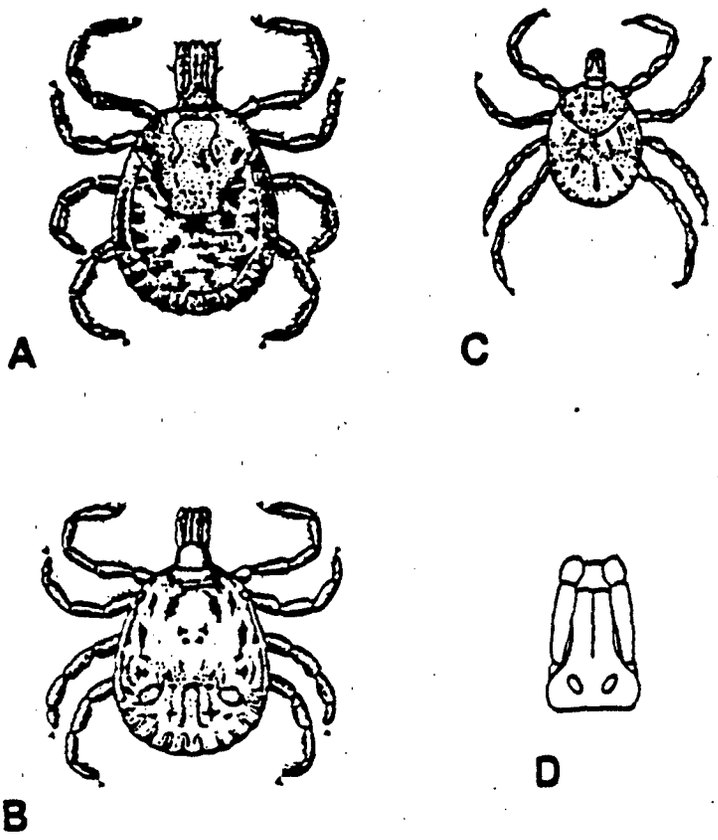


Figure 17. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Amblyomma cajennense.

**Distribution:** Amblyomma cajennense (Figs. 17, 18) occurs from extreme southern Texas, south throughout Mexico and Central America into parts of South America. Specific references include: most of Mexico (5), Panama (10, 19), several Caribbean islands including Cuba and Jamaica (22, 34), Brazil (17), Honduras (35), Venezuela (11), Costa Rica (36), Uruguay (37), Ecuador (38), Nicaragua (39), and Bolivia (40). Hoffmann(5) states that it also occurs in Guatemala, Colombia, Guayana, Paraguay, and Argentina.

**Hosts:** All active stages commonly attack man, domestic and wild animals, and ground-frequenting birds (5, 8, 11).

Figure 18. Geographic distribution of Amblyomma cajennense.

**Seasonality:** Amblyomma cajennense may be active in tropical areas year around; however, in the cooler areas at the northernmost and southernmost extent of its distribution, there may be reduced activity in midwinter.

**Diagnostic Characters:** Festoons present; eyes present; scutum ornate; basis capituli not laterally produced; coxa I not bifid; second palpal segment twice as long as wide; males with internal spur of coxa I moderately long and scutum with web-like ornamentation radiating from the center; females with external spur of coxa I distinctly longer than internal; scutum with extensive ornamentation and festoons with tubercules at posterior edge.

**Remarks:** Amblyomma cajennense is very similar to A. americanum in its aggressiveness and nonspecific feeding habits. Basically, where the southernmost distribution of A. americanum stops, A. cajennense picks up and continues southward throughout Central and South America. Longevity of larvae, nymphs, and adults, as well as numbers of eggs laid by engorged females, are similar to that of A. americanum.

## Dermacentor andersoni Stiles

### Rocky Mountain Wood Tick

**Medical Importance:** This species is the primary vector of RMSF in the Rocky Mountain states and also is known to transmit the causative agents of Colorado tick fever and tularemia. Dermacentor andersoni also produces cases of tick paralysis in the USA and Canada each year (41).

**Distribution:** Dermacentor andersoni (Figs. 19, 20) is found from the western counties of Nebraska and the Black Hills of South Dakota to the Cascade and Sierra Nevada Mountains, as well as from northern Arizona and northern New Mexico, USA, to British Columbia, Alberta, and Saskatchewan, Canada (8, 42).

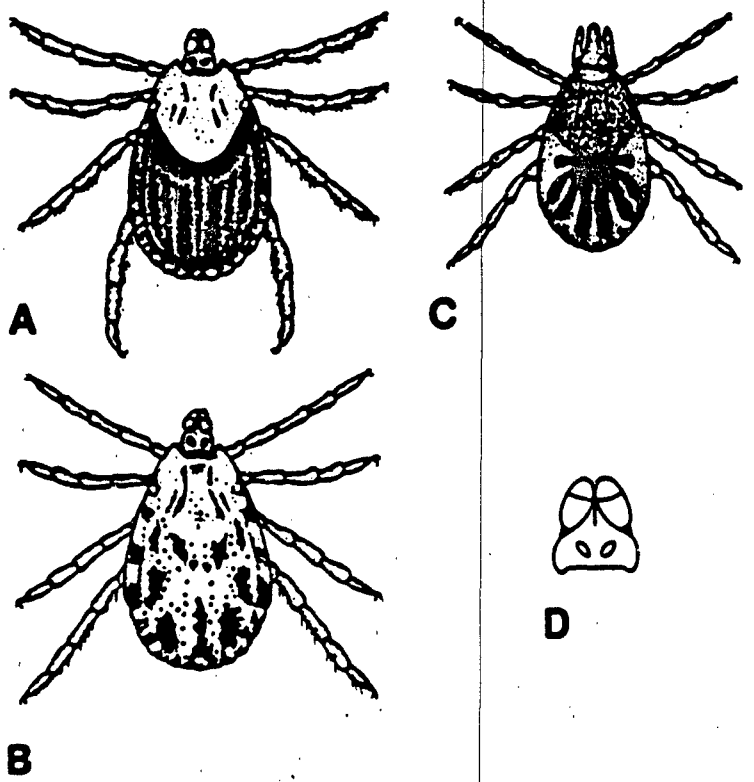


Figure 19. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Dermacentor andersoni.

**Hosts:** Immatures prefer many species of small mammals such as chipmunks and ground squirrels, whereas the adults feed mostly on cattle, sheep, deer, man, and other large mammals (8).

**Seasonality:** Larvae feed throughout the summer and adults usually appear in March, disappearing by July. Nymphs may continue to be present (although in diminishing numbers) until late summer (8).

Figure 20. Geographic distribution of Dermacentor andersoni.

**Diagnostic Characters:** Eyes and festoons present; scutum ornate; basis capitulum not laterally produced; coxa I deeply bifid; second segment of palpi about as long as wide; spurs on coxa I parallel or only a little divergent; short cornua; spiracular plate with goblets moderate in size and number; larger punctuations of the scuta very large and deep.

**Remarks:** Dermacentor andersoni is especially prevalent where there is brushy vegetation to provide good protection for small mammalian hosts of the larvae and nymphs and with sufficient forage to attract large hosts required by the adults. Unfed larvae may live for 1 to 4 months, nymphs for 10 months or more, and adults 14 months or longer. Females deposit about 4,000 eggs.

## Dermacentor occidentalis Marx

Pacific Coast Tick

**Medical Importance:** This species may transmit the agents of tularemia, RMSF and Colorado tick fever (43); it may also produce tick paralysis (41).

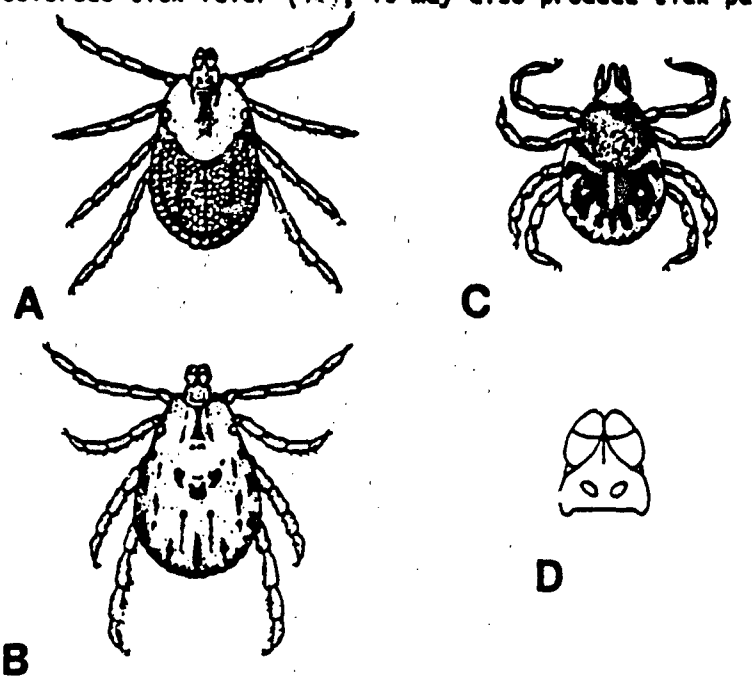


Figure 21. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Dermacentor occidentalis.

Figure 22. Geographic distribution of Dermacentor occidentalis.

**Distribution:** This species (Figs. 21, 22) occurs along the Pacific Coast and inland for several hundred miles from Oregon to the southern tip of California (42). Hoffmann(5) also reported this species from the state of Sonora, Mexico.

**Hosts:** Immatures feed primarily on small mammals with the adults preferring larger domestic animals, deer, and man (5, 8, 42).

**Seasonality:** Larvae and nymphs are active in the spring and summer whereas adults may be active year around, but predominantly in April and May.

**Diagnostic Characters:** Eyes and festoons present; scutum ornate; basis capitulum not laterally produced; coxa I deeply bifid; second segment of palpi about as long as wide; spurs on coxa I parallel or only a little divergent; long cornua.

**Remarks:** As the common name implies, D. occidentalis is confined to the Pacific Coast. Adult D. occidentalis are most numerous on hosts during the rainy season. Unfed larvae and nymphs may live up to 4 months each and adults can live up to 11 months. Females lay 3,000-4,500 eggs.

## Dermacentor variabilis (Say)

American Dog Tick

**Medical Importance:** The American Dog tick is one of the most medically important ticks in the USA and is the primary vector of RMSF in the East. It also transmits tularemia and may cause tick paralysis (44, 45).

**Distribution:** This species (Figs. 23, 24) occurs throughout the USA except in parts of the Rocky Mountain region (42). It is also established in Nova Scotia, Manitoba, and Saskatchewan, Canada (8, 46, 47) and has been reported in Mexico from the following states: Chiapas, Guanajuato, Hidalgo, Oaxaca, Puebla, San Luis Potosi, Sonora, Tamaulipas, and Yucatan (4).

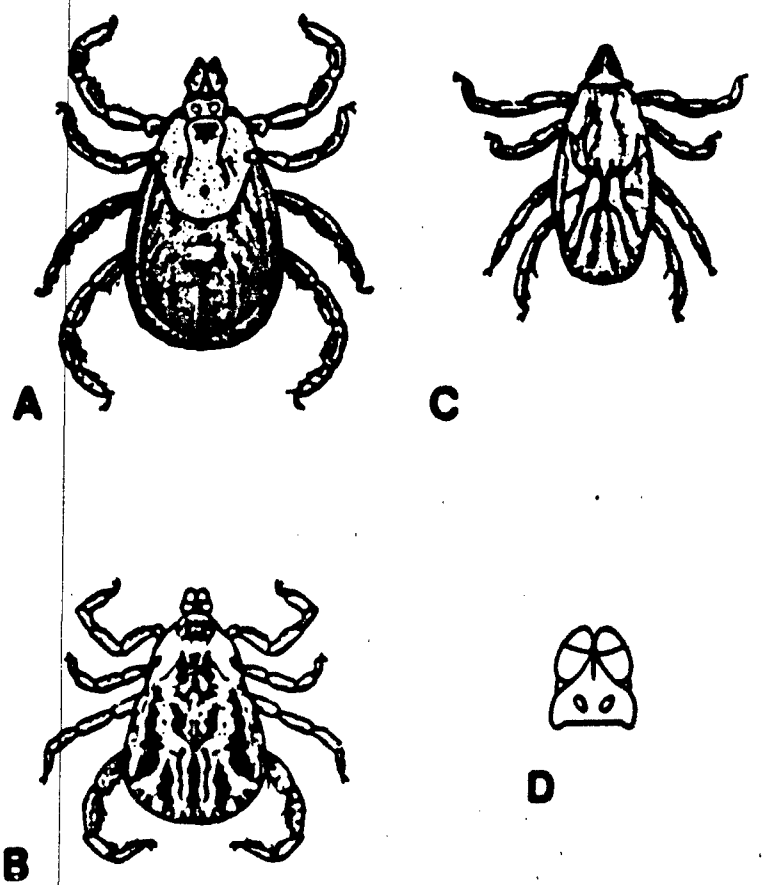


Figure 23. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Dermacentor variabilis.

**Hosts:** Immatures feed primarily on small mammals (particularly rodents), and adults prefer the domestic dog. However, adult D. variabilis will readily bite humans.

**Seasonality:** Adults are active from about mid-April to early September; nymphs predominate from June to early September and larvae are active from about late March through July (44).

Figure 24. Geographic distribution of Dermacentor variabilis.

**Diagnostic Characters:** Eyes and festoons present; scutum ornate; basis capitulum not laterally produced; coxa I deeply bifid; second segment of palpi about as long as wide; spurs on coxa I parallel or only a little divergent; short cornua; spiracular plate with goblets very numerous and small.

**Remarks:** Since D. variabilis is the principal vector of RMSF in the central and eastern USA, it should be avoided whenever possible. One important mode of transmission of RMSF is by deticking dogs. Hand-picking infected D. variabilis from dogs is dangerous because infected tick secretions on the hands may be transmitted through contact with the eyes, mucosa membranes, etc. Unfed larvae may live up to 15 months, nymphs 20 months, and adults up to 30 months or longer. Females deposit 4,000-6,500 eggs.

### Ixodes dammini Spielman, Clifford, Piesman and Corwin

Dammin's Northeastern Deer Ixodid

**Medical Importance:** Ixodes dammini transmits the causative agent of Lyme disease in the New England and Wisconsin-Minnesota areas of the USA (48) and has also been incriminated as a vector of the protozoan, Babesia microti, on Nantucket Island (49, 50).

**Distribution:** This species (Figs. 25, 26) occurs in the New England states of New York, Connecticut, and Massachusets south into New Jersey, Virginia, and Maryland; there are also established populations of I. dammini in Wisconsin and Minnesota (50). Considerable evidence indicates that I. dammini is increasing its range (50).

**Hosts:** Immatures feed on a wide variety of small mammals (especially rodents), birds, deer, dogs and man (51). Adults feed primarily on deer (52).

**Seasonality:** Larvae are active from July through September, nymphs are active from May through July, and adults are most active in the fall, winter, and early spring (50).

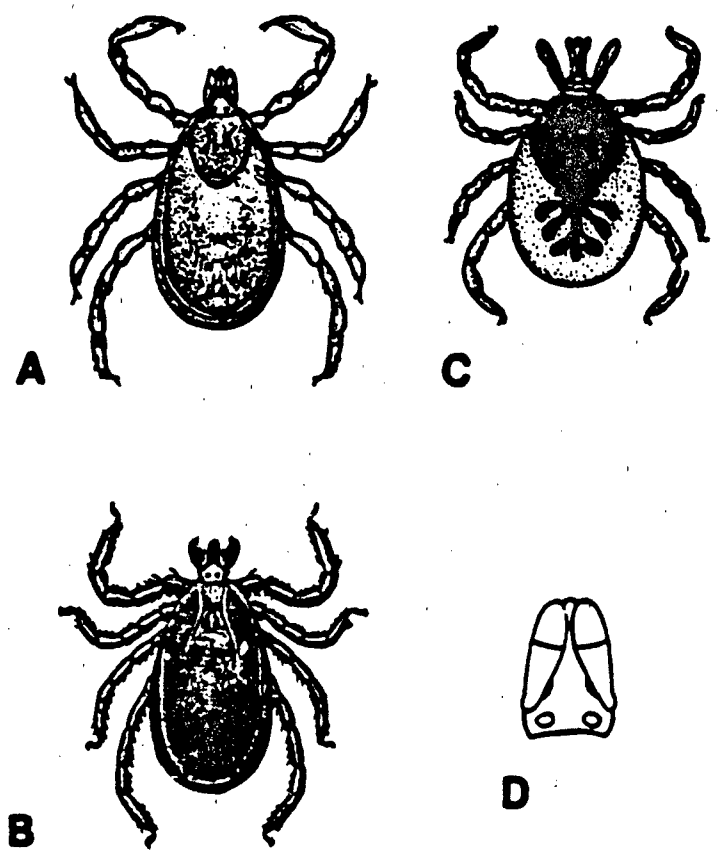


Figure 25. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Ixodes dammini.

**Diagnostic Characters:** Anal groove on ventor curves about the anus in front; festoons and eyes absent; scutum inornate; very similar to I. scapularis, but the adult female I. dammini possess a shorter and broader internal spur on coxa I and the auriculae are more pronounced and protruding; male I. dammini spiracular plates are distinctly shorter than those of I. scapularis.

**Remarks:** In contrast to nymphal I. scapularis, I. dammini nymphs bite people aggressively. This behavioral difference is very important in the epidemiology of Lyme disease.

Figure 26. Geographic distribution of Ixodes dammini.

## Ixodes pacificus Cooley and Kohls

### California Black-Legged Tick

**Medical Importance:** Ixodes pacificus has been shown to be a vector of Lyme disease spirochetes (53).

**Distribution:** This species (Figs. 27, 28) occurs along the Pacific coastal margins of British Columbia, Canada (54), and the USA (8), possibly extending into Baja California and Mexico (5).

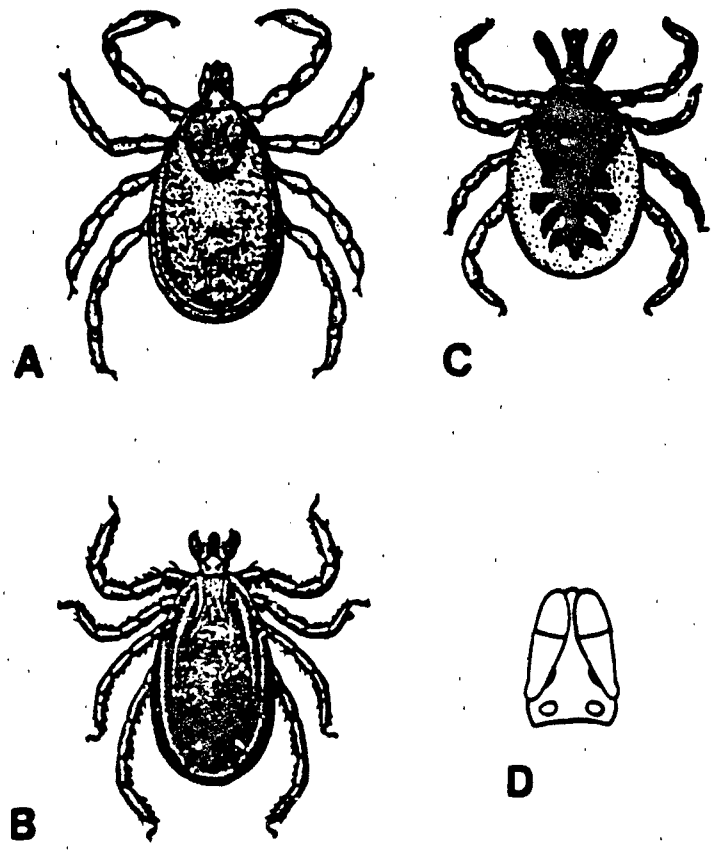


Figure 27. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Ixodes pacificus.

Figure 28. Geographic distribution of Ixodes pacificus.

**Hosts:** Ixodes pacificus immatures feed on numerous species of small mammals, birds, and lizards (55, 56). Adults feed primarily on Columbian black-tailed deer (57).

**Seasonality:** Adults are primarily active from fall to late spring with immatures active in the spring and summer.

**Diagnostic Characters:** Very similar to I. scapularis and I. dammini; anal groove on ventor curves about the anus in front; festoons and eyes absent; scutum inornate; female palps longer than wide; auriculae reduced or inapparent; cornua absent; male with long thin internal spur on coxa I; spiracular plate oval (smaller than in I. scapularis).

**Remarks:** Adult Ixodes pacificus, like I. scapularis and I. dammini, have long mouthparts, enabling them to be especially painful parasites of man. Adults are most abundant in the early spring.

## Ixodes scapularis Say

Black-Legged Tick

**Medical Importance:** Ixodes scapularis may transmit RMSF to humans and has been found naturally infected with Lyme disease spirochetes (58). Whether or not it is an efficient vector of Lyme disease is unknown at this time.

**Distribution:** This species (Figs. 29, 30) occurs in the southern Atlantic Coast states and throughout the South including Texas and Oklahoma (8). It has also been reported from the Mexican states of Jalisco and Tamaulipas (5).

**Hosts:** Immatures feed on lizards and small mammals (59); adults prefer deer but will bite people (60, 61). In Mexico, there are additional host records from dogs, cattle, and jaguar (5).

**Seasonality:** In the USA adults are active in the fall, winter, and spring whereas immatures are active in the spring and summer (62, 63).

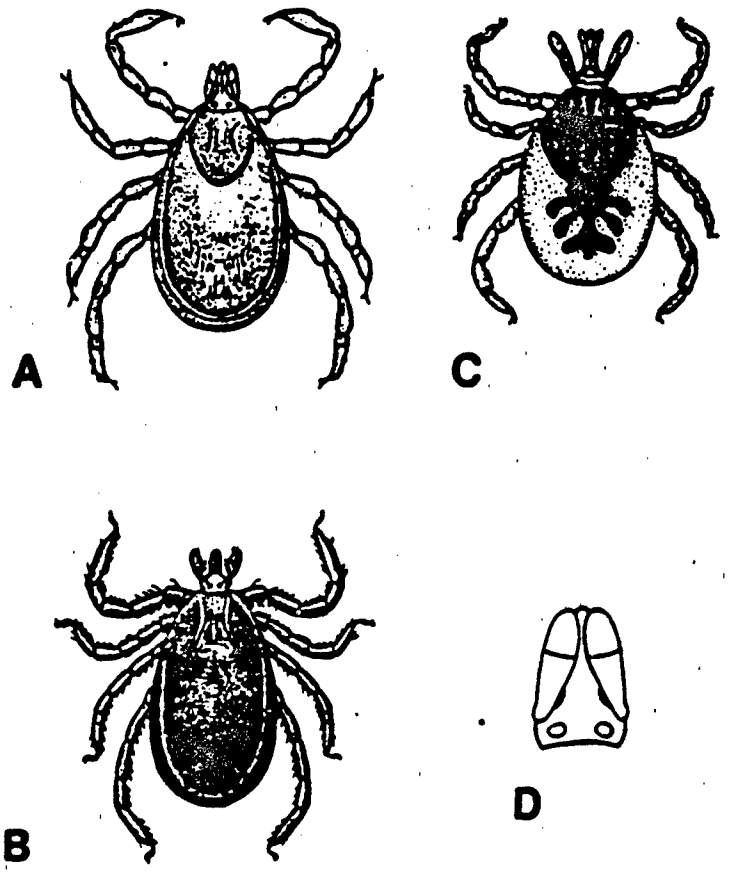


Figure 29. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Ixodes scapularis.

**Diagnostic Characters:** Very similar to I. dammini and I. pacificus; anal groove on ventor curves about the anus in front; festoons and eyes absent; scutum inornate; females palps longer than wide, auriculae reduced or inapparent; cornua small, but definite; male with long, thin internal spur on coxa I; spiracular plate elongate.

Figure 30. Geographic distribution of Ixodes scapularis.

**Remarks:** Ixodes scapularis congregates along paths, trails, and roadways in various types of forested areas such as those exhibiting mature pine-hardwoods with dogwood, wild blueberry, huckleberry, and sweetgum. I. scapularis inflicts a painful bite. The majority of hard ticks acquired by persons in the south central and southeastern states in the winter months are of this species.

## Rhipicephalus sanguineus (Latreille)

Brown Dog Tick

**Medical Importance:** Rhipicephalus sanguineus is reported to transmit the agent of RMSF in Mexico (64) and may be the vector of human cases of canine ehrlichiosis (65). In Europe, the species is a known vector of Rickettsia conorii, the causative agent of boutenneuse fever (66). Viloria (67) reported a case of tick paralysis in a dog in Venezuela caused by this species.

**Distribution:** This species (Figs. 31, 32) is probably the most widely distributed of all ticks, being found almost worldwide (8). In the Western Hemisphere there are records from most of the USA and the southeastern and southwestern parts of Canada (8, 45, 46). It has been reported in the Mexican states of Baja California, Chiapas, Chihuahua, Coahila, Durango, Guerrero, Michoacan, Morelos, Nayarit, Nuevo Leon, Oaxaca, San Luis Potosi, Sinaloa, Sonora, Tamaulipas, and Veracruz (4). This species has also been reported from Argentina (68, 69), Venezuela (9), Colombia (70), Brazil (17), Nicaragua (39), Panama (10, 19), Uruguay (71), Paraguay (72), Surinam (16), British Guiana (73), French Guiana (74), Peru (75), Costa Rica (76), and the Caribbean islands of Cuba (77), Jamaica (78), and the Bahamas (79).

**Hosts:** The dog is the principal host for Rhipicephalus sanguineus although in the immature stages it sometimes attacks numerous other animals. Man is only occasionally bitten by this species.

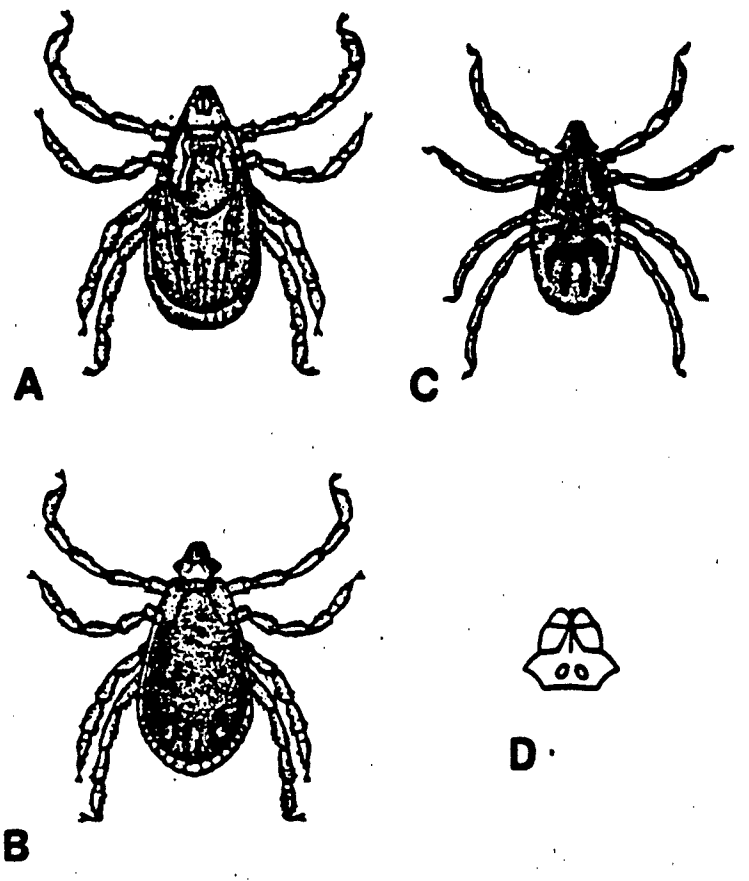


Figure 31. Adult female (A), adult male (B), nymph (C), and mouthparts (D) of Rhipicephalus sanguineus.

**Seasonality:** Rhipicephalus sanguineus may be active in the warmer parts of its range year around; however, in temperate zones adults and immatures are primarily active from late spring to early fall.

**Diagnostic Characters:** Basis capitulum laterally produced; siracular plate comma shaped; usually inornate specimens with eyes and festoons present; coxa I deeply cleft.

Figure 32. Geographic distribution of Rhipicephalus sanguineus.

**Remarks:** Rhipicephalus sanguineus is the tick most often found indoors in and around pet bedding areas. This tick has a strong tendency to crawl upward and is often seen climbing the walls of infested houses. Rhipicephalus sanguineus is mostly associated with homes and yards of pet owners and is seldom found out in the middle of a forest or uninhabited area. Unfed larvae may survive as long as 8 1/2 months, nymphs 6 months, and adults 19 months. Females usually lay 2,000-4,000 eggs.

## DEFINITION OF TERMS USED FOR DIAGNOSTIC CHARACTERS (Fig. 33)

| | |
|---|---|
| Anterior: | Toward the front end. |
| Auriculae: | Paired extensions or "ears" at the sides of the venter of the basis capituli; may be like "horns", flattened extensions, or ridges that are mild or sometimes absent. |
| Basis Capitulum: | Basal portion of capitulum on which the mouthparts are attached. May be of various shapes (hexagonal, rectangular, subtriangular, etc.) in hard ticks. |
| Bifid: | Clearly divided into two parts. |
| Cheeks: | Paired flaps at the sides of the mouthparts, which may be either fixed or movable. |
| Chelicerae: | Paired structures lying dorsally to the hypostome, which complete the cylindrical mouthparts that are inserted when the tick feeds. |
| Cornua: | Small projections extending from the dorsal, posterolateral angles of basis capituli. |

Coxae: (sing. Coxa) — Small sclerotized plates on the venter representing the first segment of the leg to which the trochanters are movably attached. From anterior to posterior, the coxae are designated by Roman numerals I, II, III, and IV. Bifid coxae are those that are cleft, divided, or forked.

Dentition: — Refers to the presence of denticles (teeth) on the ventral side of the hypostome. The numerical arrangement of the rows of denticles is expressed by dentition formulas. Thus, dentition 3/3 means that there are 3 longitudinal rows of denticles on each side of the median line of the hypostome.

Discs: — Limited areas or spots which are the external evidence of modification of the structure of the body wall at the points of attachment of the dorso-ventral muscles. They are usually in a symmetrical pattern and may or may not be evident on the underside.

Dorsal: — Pertaining to the back or top of the body.

Dorsal Humps: — Humps or elevations on the dorsal walls of the articles of the legs but not including the subapical dorsal protuberance.

Eyes: — Eyes, when present, are located on the lateral edges of the scutum about even with the site of leg I attachment in hard ticks. Soft ticks may have eyes on their lateral margins near Coxae I and II.

Festoons: — Uniform rectangular areas, separated by distinct grooves, located on the posterior margin of most genera of hard ticks. Very distinct areas in unengorged specimens but may not be visible in fully engorged females.

Grooves: — Linear depressions or furrows, primarily on the ventral surface.

| | |
|---|---|
| Hood: | The anterior projection of the integument in soft ticks above and covering the mouthparts. |
| Hypostome: | Median ventral structure of the mouthparts that lies parallel to and between the palps. It bears the "recurved teeth" or denticles. |
| Inornate: | Absence of a color pattern on the scutum. |
| Integument: | Outer covering or cuticle of the tick's body. |
| Mammillae: | Elevations of various forms found on the integument in Ornithodoros species. |
| Micromammillae: | Very small, rounded elevations of nearly uniform size on the surface of the legs and sometimes the capitulum. |
| Ornate: | Definite enamel-like color pattern superimposed on the base color of the integument in hard ticks. |
| Palps: (Pl. palpi) | Paired articulated appendages located to the front and sides of the basis capituli and lying parallel with the hypostome. |
| Posterior: | Toward the rear end. |
| Protuberance: | Any elevation above the surface of the integument. |
| Scutum: | The sclerotized dorsal plate posterior to the capitulum in hard ticks. It covers almost the entire dorsal surface in the male, and about one-half the dorsal surface in the unengorged female. |

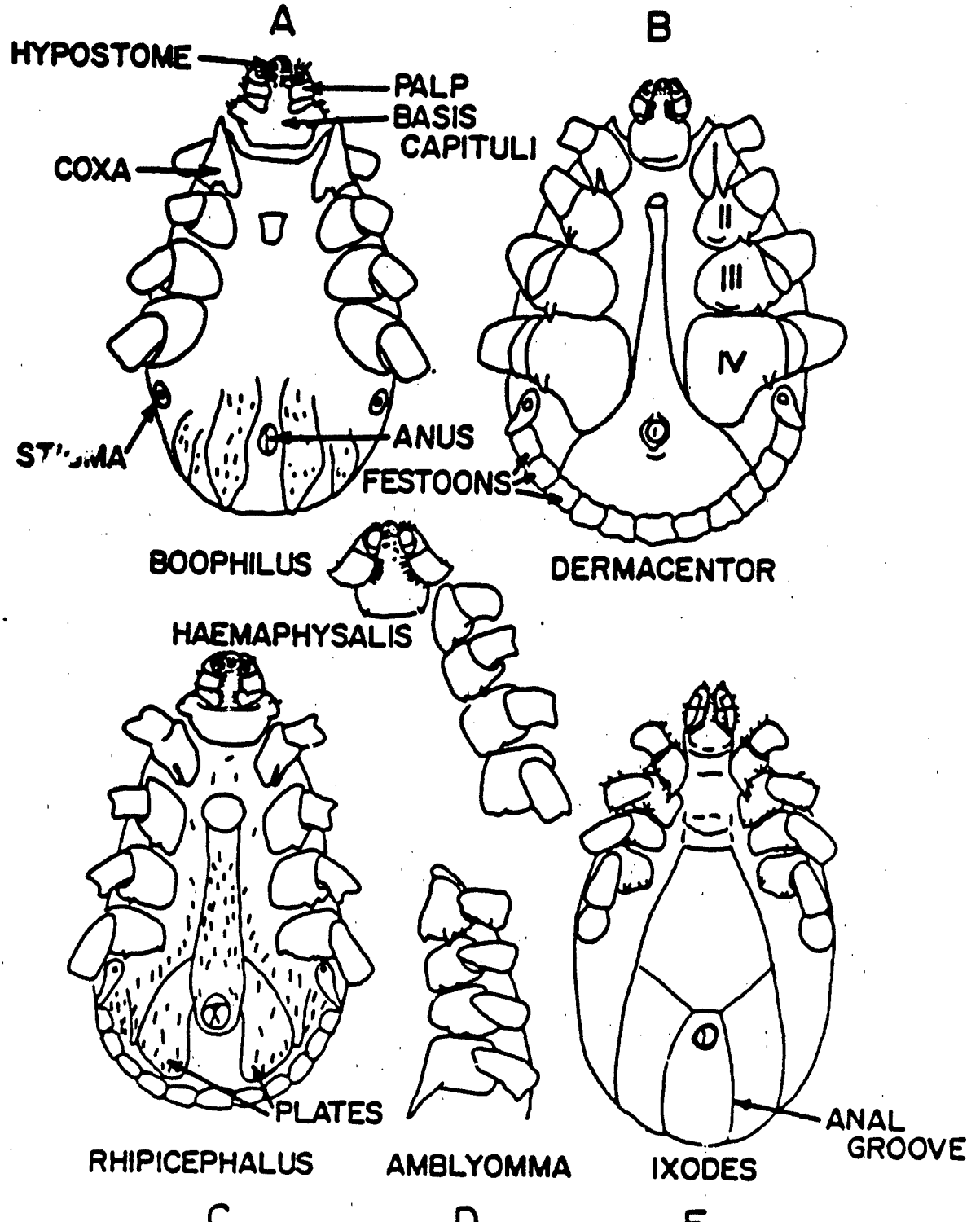


Figure 33. Diagnostic characters used in hard tick identifications (Redrawn with permission from Georgi, 1974; Parasitology for Veterinarians, W.B. Saunders Co.).

| | |
|---|---|
| Spurs: | Coxal spurs are projections from the posterior surface or posterior margin of the coxae; they may be rounded or pointed, small or large. Projections on the median side are called internal spurs; those on the lateral side are called external spurs. |
| Subapical Dorsal Protuberance: | The protuberance sometimes present distal of the Haller's organ (on tarsus) and when much drawn out produces the bifurcate termination of the tarsus. It is distinctly different from the dorsal humps. |
| Tarsus: (Pl. tarsi) | The terminal leg segment. |

## SUGGESTIONS FOR TICK CONTROL

### Personal Protection

One of the best personal protective techniques to guard against ticks is to tuck pants legs into one's boots and treat the lower one-third of the pants with repellents. In the military, blousing the fatigues works well. Blousing or tucking trousers forces ticks to crawl up the outside of pants instead of the inside, thus making them easier to spot and remove. Shirt-tails should also be tucked in for the same reason. Some of the newer repellents like Permanone® (permethrin) work well and can be used to impregnate pants legs and will effectively kill ticks crawling thereon for several days. For example, Schreck et al. (80) demonstrated in a research study that military field uniforms treated with 0.5% permethrin provided 100% protection to humans against all life stages of Ixodes dammini.

## Area Control

Several pesticides may be used effectively to control ticks in infested indoor and outdoor areas. Chlorpyrifos (Dursban®) in the 41% EC formulation can be used, diluted with water, at the rate of 1,171 ml (39.6 oz) concentrate per hectare (2.46 a) for effective outdoor tick control. The solution can be applied to roadsides, footpaths, trails, bivouac sites, and other infested non-cropland areas using a hydraulic sprayer, mist applicator, backpack sprayer or other suitable hand or power spray equipment. Treat low underbrush, grassy areas, weeds, and ground surface and debris. Treated areas should be vacated until spray has dried. Diazinon (48% EC formulation) may be used indoors as a 0.5% residual spray or outdoors as a 0.2% residual spray for tick control. Indoors, use the pesticide as a spot treatment only, including cracks and crevices (especially around pet bedding areas). Outdoors, apply in a 1.6 m (5 ft) wide band around the structure or area to be protected, as well as to the structure wall from ground level to a height of approximately 1 m (3.28 ft).

## RECOMMENDATIONS FOR TICK REMOVAL

"What is the best way to remove a tick?" The answers are varied depending on who you ask and what part of the country you are in because many folklore methods are available. Hard ticks attach themselves firmly to a host for a feeding period of several days and are especially difficult to remove. Methods such as touching attached ticks with a hot match, coating them with mineral oil, petroleum jelly or some other substance, and/or "unscrewing" them are but a few of the home remedies that supposedly induce them to "back out."

Since the lengthy feeding period is an important factor in disease transmission by ticks, it is crucial that a tick be removed as soon as possible after it is discovered to reduce chances of infection by disease organisms. During several years of field research with ticks, I often had to remove them from myself or others and pulling them straight off with blunt forceps (tweezers) seemed to work best. There has been some research in this area. A study by J.H. Theis (81) advocated tick removal by the use

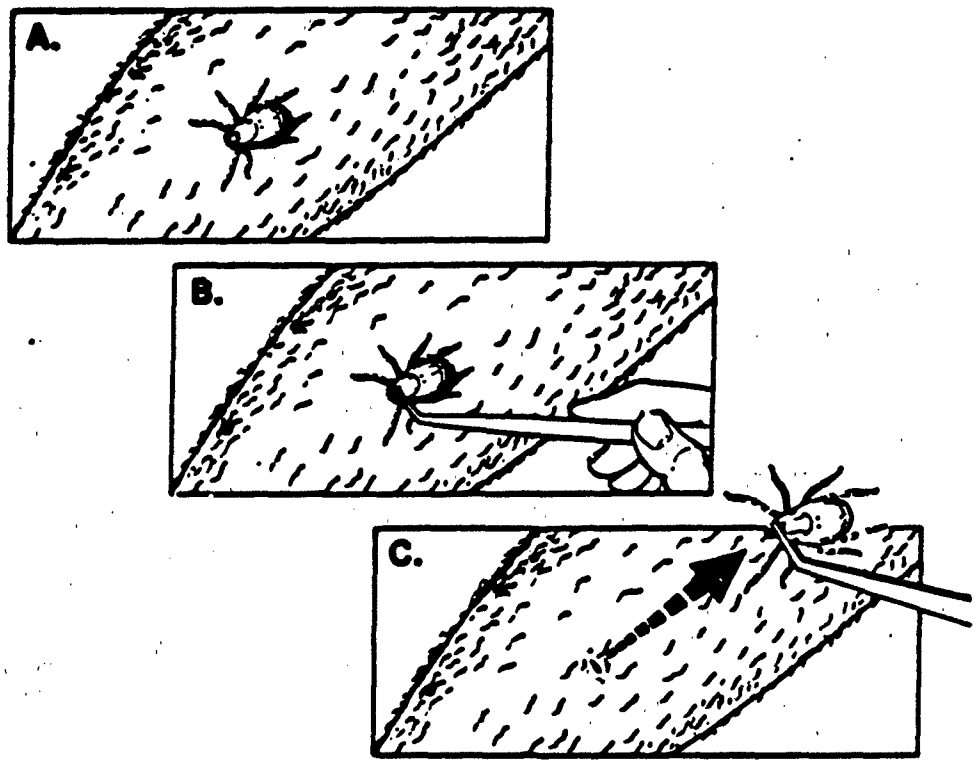


Figure 34. Recommended method for tick removal: grab tick with forceps as close to the skin as possible and pull straight off.

of forceps or protected fingers using a steady retracting pressure. Recently, Glen Needham (82) at Ohio State University did a very good research study of this problem. He evaluated 5 methods commonly used for tick removal: (a) petroleum jelly, (b) fingernail polish, (c) 70% isopropyl alcohol, (d) hot kitchen match, and (e) forcible removal with forceps. Needham found that the commonly advocated methods are either ineffective, or worse, actually created greater problems. If petroleum jelly or some other substance causes the tick to back out on its own (and most often it does not), the cement surrounding the mouthparts used for attachment remains in the skin where it continues to cause irritation. Touching the tick with a hot match may cause it to burst, increasing risk of disease germ exposure.

Furthermore, hot objects may induce ticks to salivate or regurgitate infected fluids into the wound (83). "Unscrewing" a tick is likely to leave broken mouthparts in the host's skin.

Needham recommended the following procedure for tick removal: (a) use blunt forceps or tweezers; (b) grasp the tick as close to the skin surface as possible (Fig. 34) and pull upward with steady, even pressure; (c) take care not to squeeze, crush, or puncture the tick; (d) do not handle the tick with bare hands because infectious agents may enter via mucous membranes or breaks in the skin; and (e) after removing the tick, disinfect the bite site and wash hands thoroughly with soap and water.

Rocky Mountain spotted fever and Lyme disease (the two most important tickborne diseases in the USA) are usually successfully treated with antibiotics in their initial stages; therefore, early diagnosis is imperative. For this reason marking the day of a tick bite on a calendar is a good idea. If unexplained disease symptoms occur within 2 weeks from this day, a physician should be specifically informed of the tick bite. This method has proven to be very helpful in diagnosis of tickborne disease. Although there are a number of well-known tick removal methods (mostly folklore), the best one seems to be the simplest--pull them straight off with blunt forceps and disinfect the bite site.

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